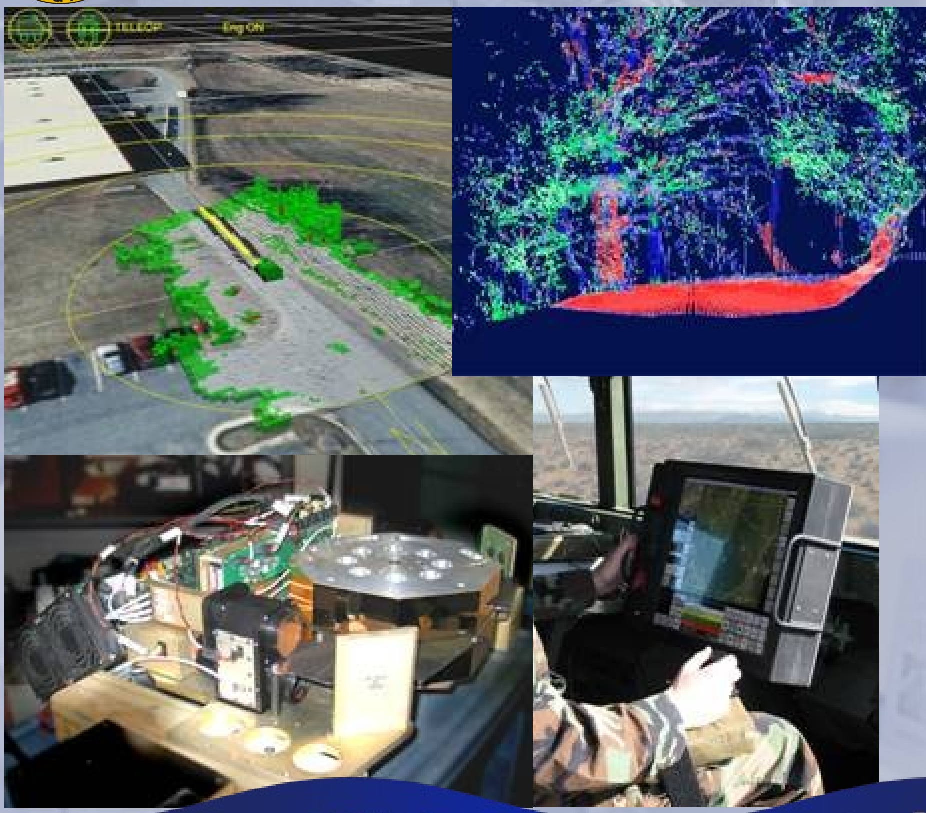
Robotics Collaborative Technology Alliance



Charles Shoemaker
ARL Collaborative Alliance Manager

Kevin Bonner
Consortium Manager, General Dynamics Robotic Systems

2004 Research Laboratory of the Year

Robotics
Collaborative Technology Alliance

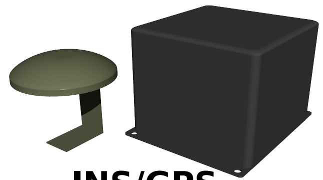
Providing technology to enable near-autonomous unmanned systems

Robotics CTA Technology is the basis for the FCS Autonomous Navigation System that will be used for both manned and unmanned ground vehicles

Transitioning Key Technology to FCS Autonomous Navigation System

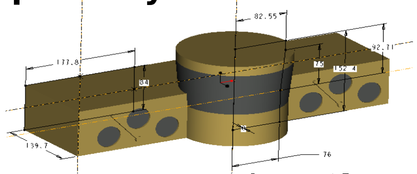
ANS Components

Computer System



INS/GPS

MMW Radar



Perception Module

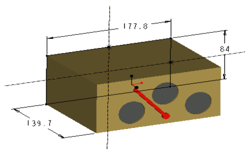
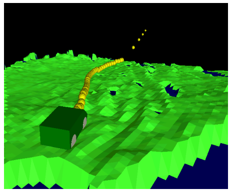


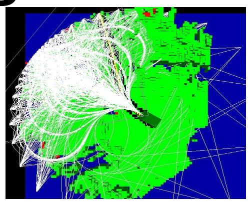
Image Perception Module

Perception Based Planning & Control

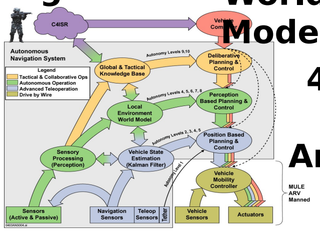
Sensory Processing



Local World Model

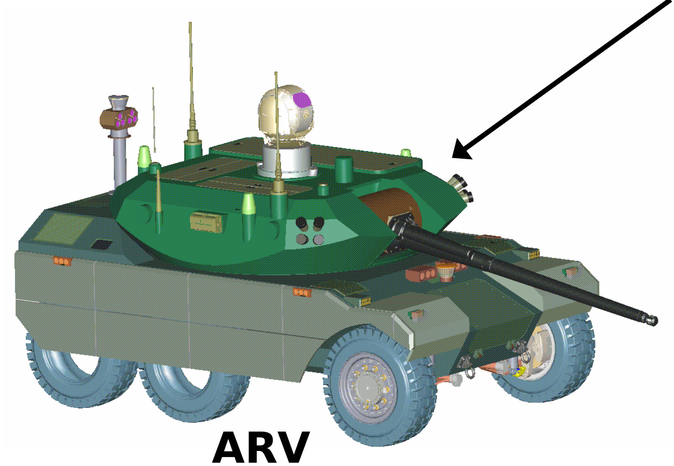


Planning & Control



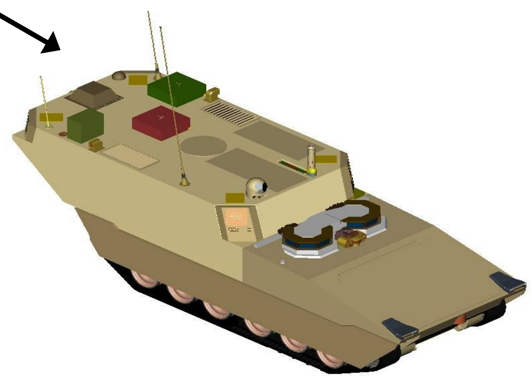
4D/RCS Software Architecture

ANS Integrated on FCS Platforms



ARV
(2 Variants)

MULE
(3 Variants)



MGV
(8 Variants)

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Consortium Partners

- GD Robotic Systems (Lead)
- Applied Systems Intelligence
- BAE Systems
- Jet Propulsion Lab
- Micro Analysis & Design
- Sarnoff Corporation
- SRI International
- Carnegie Mellon University
- Florida A&M University
- University of Maryland

Objectives

Make the research investments that support the Army's autonomous mobility goals:

- *Develop perception technologies that allow robotic vehicles to understand their environment;*
- *Develop intelligent control technologies enabling robotic systems to autonomously plan, execute, and monitor operational tasks undertaken in complex, tactical environments;*

Technical Areas

- Perception
- Intelligent Control & Behaviors
- Human-Machine Interface

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Perception

Use sensing and perception to automatically anticipate, detect, and understand conditions that may affect mobility performance

Understand the motion of other agents to safeguard the vehicle

Anticipate conditions at long enough range to enable early decisions

Detect terrain conditions that may impair mobility and compromise mission

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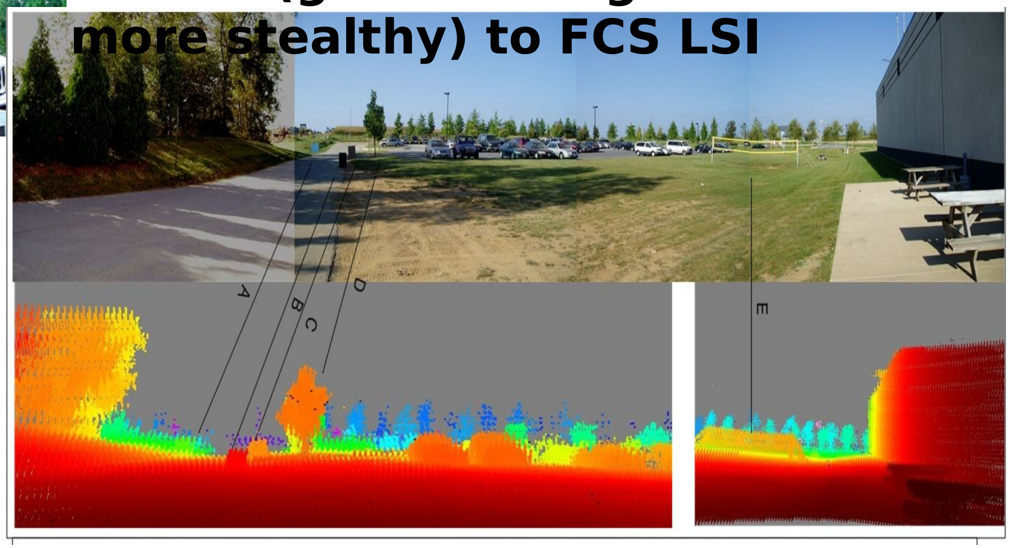
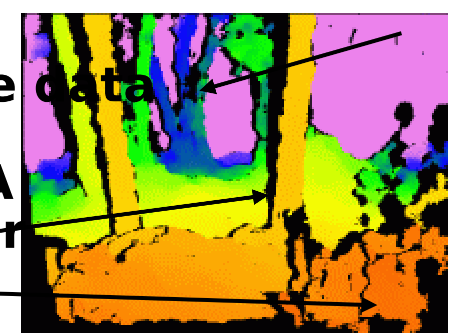
Advances in Perception

Higher speed, robust autonomous mobility

Developed and transitioned Next Generation Ladar Sensor (greater range & resolution, smaller footprint, more stealthy) to FCS LSI





Improved stereo: Increased stereo range data on tall, thin objects without sacrificing accuracy, implemented analysis on FPGA to increase frame rate – allows for higher speed vehicle operation

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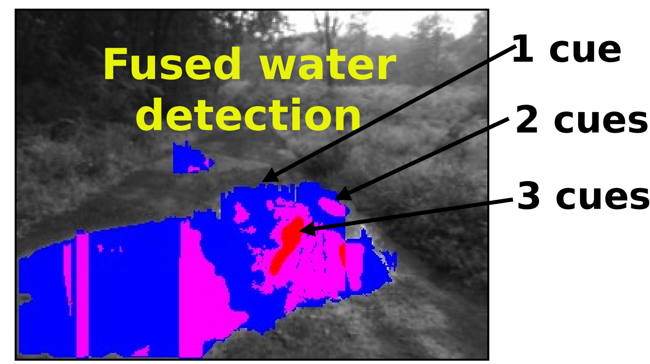
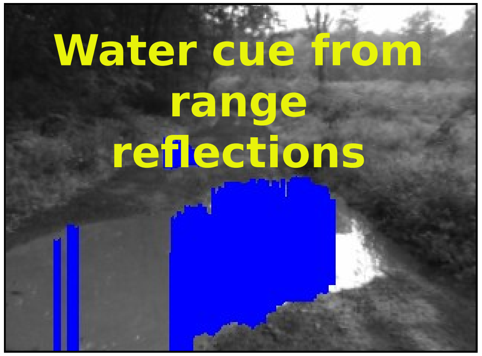
Advances in Perception

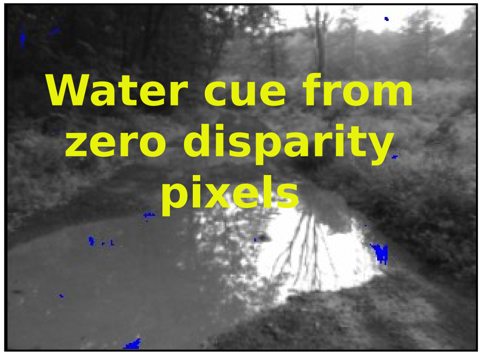
Detect terrain conditions that may impair mobility and compromise mission

Demonstrated specialized algorithms utilizing multi-spectral data (visible, IR. & polarization) to determine material classification

Detection of water using Multiple cues







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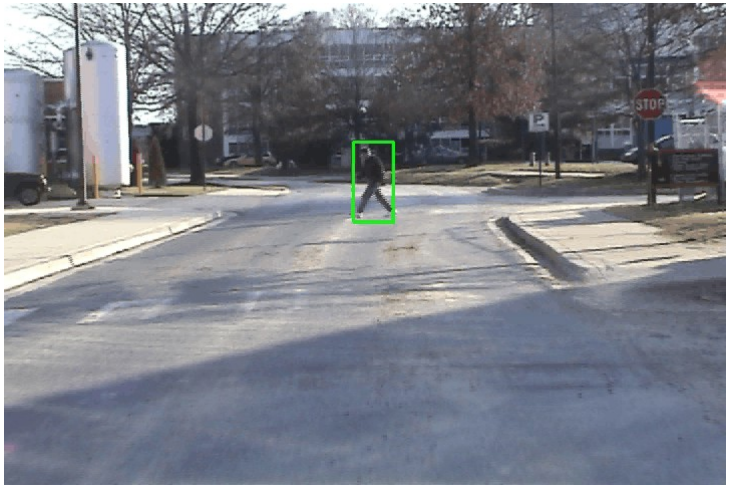
Advances in Perception

Safe operations among people & other vehicles

Demonstrated Ladar-based detection & tracking of moving objects from a moving vehicle



Initial demonstration of human detection and tracking (offline) from a moving platform

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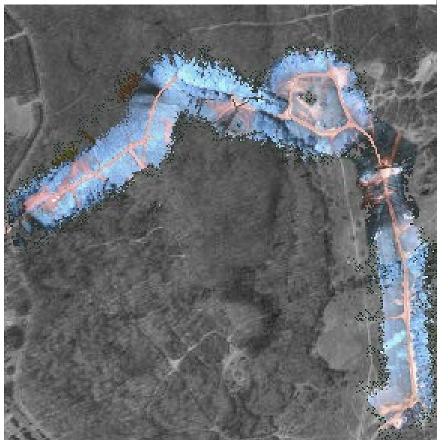
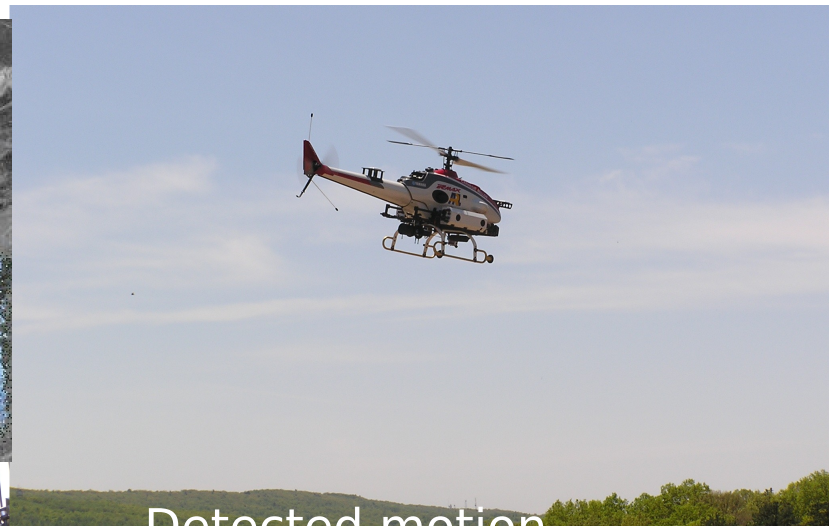
Advances in Perception

Air-Ground Cooperative Perception





Integrated air platfor
(both fixed wing &
Rotary wing) into CTA
Infrastructure

Developed initial
Implementation of
Obstacle detection La
For rotary wing UAV

Improved Ladar-base
mapping algorithms
(change detection)

Demonstrated Moving
Target Detection

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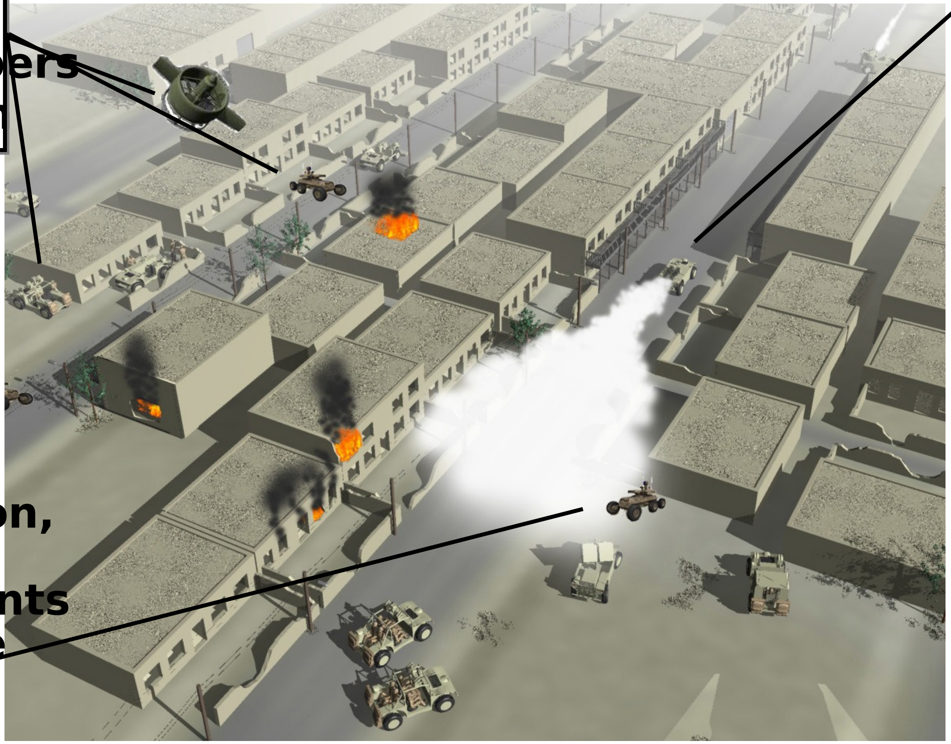
Intelligent Control Architectures

Develop an intelligent control architecture & technologies required for robust, flexible, autonomous operation of unman systems in tactical operations.

Collaboration among heterogeneous members of the small unit team

Identification and specification of tactical behavior



Real-time planning processes that effectively utilize contextual information, commanders intent, and realistic constraints to develop actionable plans for dynamic environments

Real-time fusion of information from multiples sources into a coherent world model

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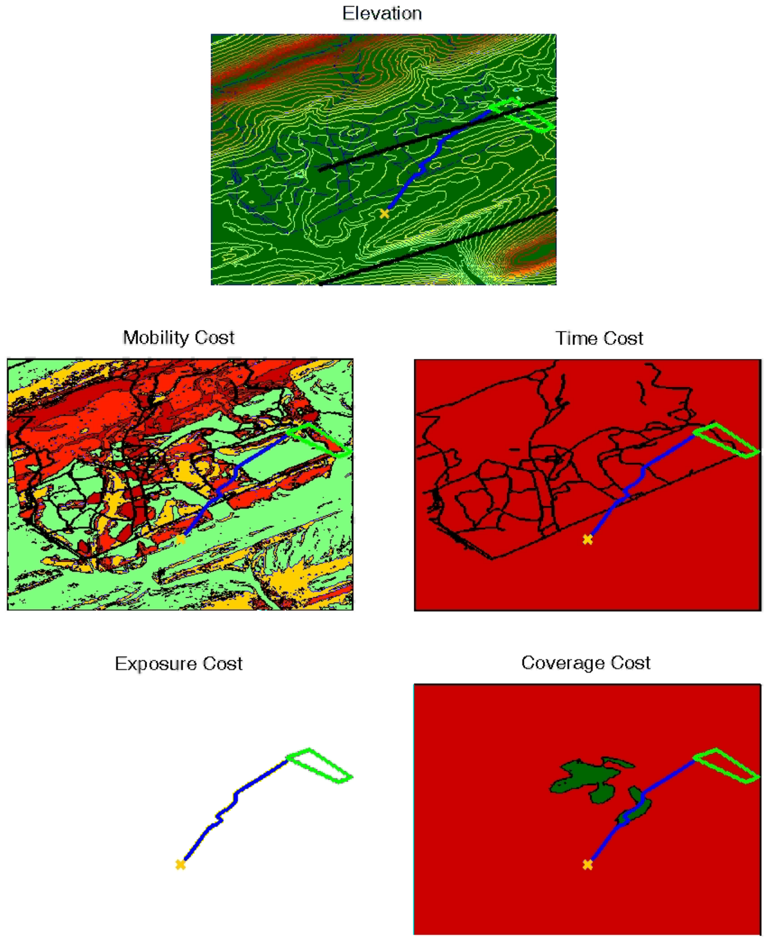
Advances in Intelligent Control

Real-time planning processes that use realistic constraints



Multi-metric route planning

- Route must be re-planned when environment changes
- Threat appears, changing the exposure costs
- Route is re-planned to account for new threat information
- Part of Geometric Planning Package (GPP) transitioned to “Smart WMI”

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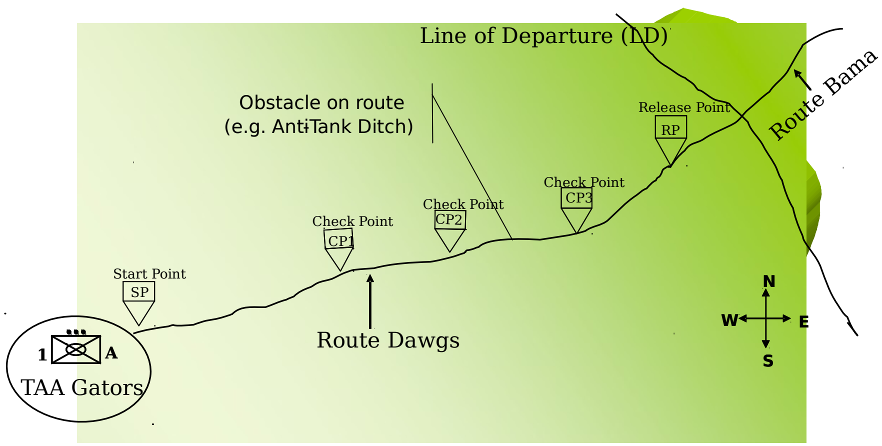
Advances in Intelligent Control

Collaboration among heterogeneous members of the small uni

Task Decomposition & Planning



OCL directive “**1st Platoon, Alpha Company Recon CP1, CP2 Complete NLT 2200 hrs PlanAssault on Objective Silver**” decomposes as:

- ***Who*** – 1st Platoon, Alpha Company
- ***What*** – Recon
- ***Where*** – CP1, CP2, CP3, CP4, CP5, Objective Silver
- ***When*** – Complete NLT 2200 hrs
- ***Why*** –PlanAssault on Objective Silver

- **Operational Control Language (OCL) parser for reconnaissance missions completed**
- **Automated UGV on-road & stealthy r selection and Observation Point (OP selection implemented**
- **Decision Support System (DSS) integ into tablet PC, HMMWV-mounted OC & integrated into Systems Integratio**
- **Transitioned to “Smart WMI,” VTI, &**

Robotic SI
“Smart WMI”
(OCU & DSS)
with rSAF

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Human-Machine Interface

Source of operator effectiveness data…Robotics NCO.

Maintain situation awareness despite intermittent contact

Effectively control multiple unmanned systems

Maintain trust in autonomous systems

Research Toolset
Realistic Environmen
- **Operator “on the mov**
- **Degraded weather**

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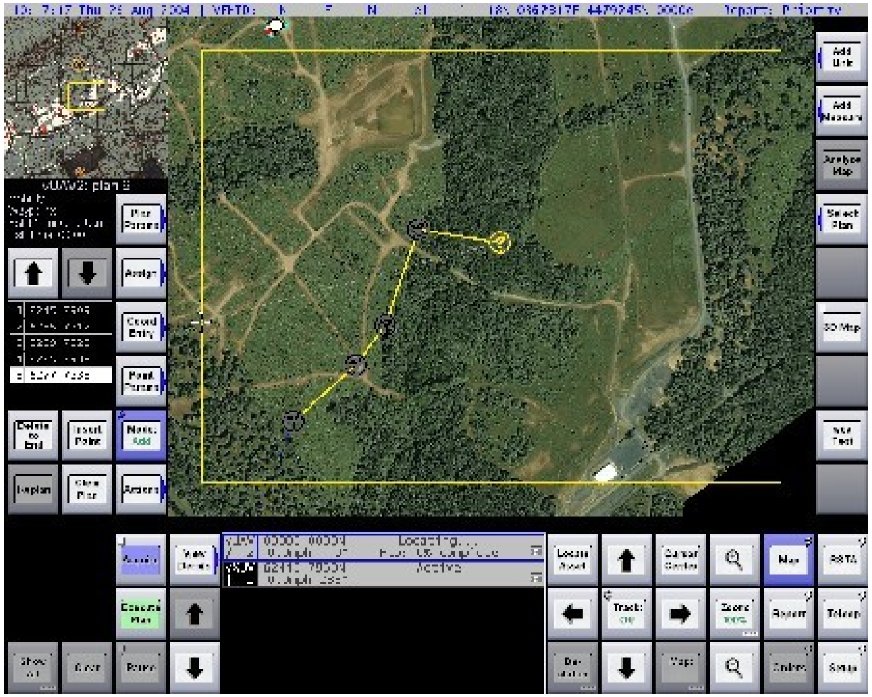
Advances in Human-Machine Interface

Effectively control multiple air & ground unmanned systems

Developed and implemented scalable family of Operator Control Units

Plan & execute integrated missions with UGVs, UAVs, UGs, and manned systems

Implemented robust voice control



Robotics

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Advances in Human-Machine Interface

- ***Effectively control multiple unmanned systems***
- ***Manage combined mobility & mission package, e.g., ATR, work***
- ***Maintain trust in autonomous systems***

Systems Integration Lab

Developed and implemented Syst Integration Laboratory (SIL), a specialized simulation environme combining “smart OCU” and One

SIL now being utilized by Robotics CTA, ARL/HRED, STTC and soon others to examine workload and trust in automation issues associated With mobile unmanned systems

Robotics
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Provides essential technology for the coming wave of intelligent tactical unmanned systems